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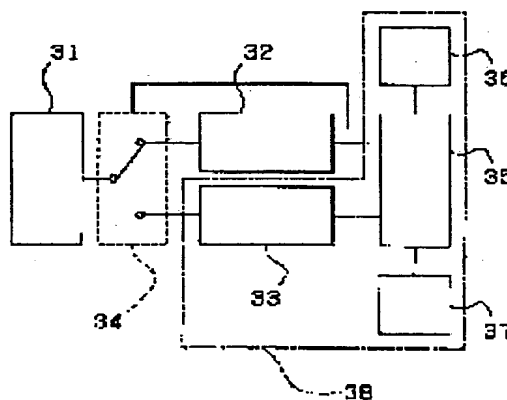
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(54) INK JET PRINTER AND CIRCUIT AND METHOD FOR DETECTING  
BUBBLE

(57)Abstract:

PROBLEM TO BE SOLVED: To  
adequately execute ink ejection and to  
obtain a high quality and stable image by a  
method wherein bubbles in ink is detected  
and an optimum head recovering operation  
is executed.

SOLUTION: This ink jet printer a print  
head 31, a head driving circuit 32 for  
driving the print head 31, a bubble  
detecting circuit 38 and a switching circuit  
34 that switches connections from the  
head 31 to the head driving circuit 32 and  
to the bubble detecting circuit 38. The  
bubble detecting circuit 38 consists of an  
impedance measuring circuit 33 which can be switched to be connected  
to the head 31, a CPU 35, a memory 36 and a table memory 37.



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**CLAIMS**

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[Claim(s)]

[Claim 1] The ink jet printer characterized by having an impedance measurement means to measure the impedance in the frequency of the predetermined range of the above-mentioned head, a frequency-characteristics creation means to create the frequency characteristics of the measured impedance, and a distinction means to distinguish whether air bubbles have adhered to the above-mentioned piezoelectric device with the above-mentioned frequency characteristics, in the ink jet printer which spouts ink to a print-ed medium by the drive of the piezoelectric device of a head.

[Claim 2] The ink jet printer according to claim 1 characterized by having further the means for switching which switches the head driving means which drives the above-mentioned head, and the above-mentioned head driving means and the above-mentioned impedance measurement means.

[Claim 3] The ink jet printer according to claim 1 characterized by having further a means to remove the air bubbles adhering to the above-mentioned piezoelectric device when adhesion of air bubbles is distinguished by the above-mentioned distinction means.

[Claim 4] The ink jet printer according to claim 1 to 3 characterized by having further the storage means in which elimination and writing are possible, and making it make the above-mentioned storage means memorize the impedance of the above-mentioned head at the time of initialization.

[Claim 5] The cellular detector characterized by having a means to measure the impedance in the frequency of the predetermined range of the above-mentioned head, a means to create the frequency characteristics of the measured impedance, and a means to distinguish whether air bubbles have adhered to the above-mentioned piezoelectric

device with the above-mentioned frequency characteristics, in the equipment which makes a liquid blow off by the drive of the piezoelectric device of a head.

[Claim 6] The cellular detection approach characterized by having the measurement process which measures the impedance of the frequency of the predetermined range of a head, and the distinction process which distinguishes the existence of the air bubbles adhering to the above-mentioned head from the frequency characteristics of the measured impedance.

[Claim 7] The above-mentioned distinction process is the cellular detection approach according to claim 6 characterized by to have the process which creates the frequency characteristics of the impedance measured in the above-mentioned measurement process, a process in comparison with the frequency characteristics of the impedance which was able to determine beforehand the frequency characteristics of the measurement impedance created by doing in this way, and the process which distinguishes the existence of the air bubbles adhering to the above-mentioned head based on the above-mentioned comparison result.

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the ink jet-type printer which carries out the print of the ink to the shape of jet especially at a print-ed medium with respect to the equipment which spouts a liquid, for example, the coater which applies the humidifier which carries out the regurgitation of the water, and ink.

[0002]

[Description of the Prior Art] Drawing 6 shows the conventional ink jet printer indicated by JP,6-336026,A.

[0003] In drawing 6 , 1 expresses the head of an ink jet print and this head 1 consists of two or more nozzles 2, the pressure room 17 formed in housing 18, an ink way 15, piezo piezoelectric devices 16a and 16b to which the volume of the pressure room 17 is changed, and a heater 19 which heats housing 18.

[0004] Moreover, the ink cartridge 6 equipped with the ink container 4 is attached in housing 18, and the ink container 4 is open for free passage for two or more nozzles 2 through the ink way 15. Moreover, in the ink container 4, the porous bodies 9 and 13 for carrying out absorption maintenance of the ink are held, and the heater 5 for heating is attached in the external surface of the ink container 4.

[0005] Next, actuation of this conventional ink jet printer is explained. Usually, although ink is filled with the solid condition on the ink way 15, if an electrical potential difference is further impressed to the heater 19 of a head 1, the heater 5 of the ink container 4 and the ink absorbed by the ink and the porous bodies 9 and 13 in the ink way 15 will be melted. And the volume of the pressure room 17 is changed and a liquid ink drop is made to blow off from a nozzle 2 by impressing an electrical potential

difference to the piezo piezoelectric devices 16a and 16b in this condition, and vibrating them. In connection with this, the ink absorbed by porous bodies 9 and 13 is supplied to the small [ every ] pressure room 17. A print object is obtained by making ink blow off from a head 1 by this actuation, and making it adhere to a form.

[0006]

[Problem(s) to be Solved by the Invention] In the conventional ink jet printer, when air bubbles went into the ink way 15, the normal ink regurgitation becomes impossible from two or more nozzles 2, the stripe went into the print object as a result, and there was a trouble that the quality and stabilized print object was no longer obtained.

[0007] Moreover, there is no means to check before carrying out the print of the existence of air bubbles, and the one-sheet print of the test pattern with which the regurgitation of ink judges whether it is normal needed to be carried out.

[0008] Moreover, when the print of the test pattern was carried out and a print object with air bubbles normal owing to was not obtained, ink supply recovery was performed as a recovery means, again, the print of the test pattern had to be carried out for the check, the repeat of checking whether ink has breathed out normally had to be performed, and there was a trouble that time amount and print cost started.

[0009] This invention aims at offering the ink jet printer which the impedance in the frequency of the arbitration of the piezoelectric device of a head is measured, and the frequency characteristics of an impedance are created, it distinguishes whether air bubbles have adhered to the ink interior of a room with those frequency characteristics, and ink supply recovery is automatically performed when air bubbles have adhered, and can perform cellular removal before being made in order to solve the trouble mentioned above, and carrying out a print.

[0010] Moreover, other purposes of this invention lose a test pattern print, and are to offer the ink jet printer which can reduce time amount and print cost.

[0011] Furthermore, the purpose of further others of this invention is to offer the cellular detector and the cellular detection approach of detecting that air bubbles adhered to the head.

[0012]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the ink jet printer concerning this invention is equipped with an impedance measurement means measure the impedance in the

frequency of the predetermined range of the above-mentioned head, a frequency-characteristics creation means create the frequency characteristics of the measured impedance, and a distinction means distinguish whether air bubbles have adhered to the above-mentioned piezoelectric device with the above-mentioned frequency characteristics, in the ink jet printer which spouts ink to a print-ed medium by the drive of the piezoelectric device of a head.

[0013] Moreover, the ink jet printer of this invention is further equipped with the means for switching which switches the head driving means which drives the above-mentioned head, and the above-mentioned head driving means and the above-mentioned impedance measurement means.

[0014] Furthermore, the ink jet printer of this invention is further equipped with a means to remove the air bubbles adhering to the above-mentioned piezoelectric device, when adhesion of air bubbles is distinguished by the above-mentioned distinction means.

[0015] The ink jet printer of this invention is further equipped with the storage means in which elimination and writing are possible, and it is made to make the above-mentioned storage means memorize the impedance of the above-mentioned head further again at the time of initialization.

[0016] Moreover, the cellular detector concerning this invention is equipped with a means to measure the impedance in the frequency of the predetermined range of the above-mentioned head, a means to create the frequency characteristics of the measured impedance, and a means to distinguish whether air bubbles have adhered to the above-mentioned piezoelectric device with the above-mentioned frequency characteristics, in the equipment which makes a liquid blow off by the drive of the piezoelectric device of a head.

[0017] Moreover, the cellular detection approach of this invention is equipped with the measurement process which measures the impedance of the frequency of the predetermined range of a head, and the distinction process which distinguishes the existence of the air bubbles adhering to the above-mentioned head from the frequency characteristics of the measured impedance.

[0018] Furthermore, the above-mentioned distinction process is equipped with the process which creates the frequency characteristics of the impedance measured in the above-mentioned measurement process, the process in comparison with the frequency characteristics of the impedance which was able to determine beforehand the frequency

characteristics of the measurement impedance created by doing in this way, and the process which distinguishes the existence of the air bubbles adhering to the above-mentioned head based on the above-mentioned comparison result.

[0019]

[Embodiment of the Invention] Hereafter, the gestalt of implementation of this invention is explained with reference to an accompanying drawing.

[0020] Gestalt 1. drawing 1 of operation shows the outline configuration of the ink jet printer by the gestalt of 1 implementation of this invention.

[0021] The ink jet printer is equipped with the change-over circuit 34 which switches alternatively connection between the head 31 for a print, the head drive circuit 32 which drives a head 31, the cellular detector 38, and a head 31, the head drive circuit 32 and the cellular detector 38 in drawing 1 .

[0022] The cellular detector 38 is constituted by the impedance measurement circuit 33 which has connection with a head 31 switched by the switch circuit 34, CPU35, memory 36, and the table memory 37.

[0023] The impedance measurement circuit 33 detects the electrical potential difference and current in a setting frequency of the head section 120 ( drawing 3 ) of a head 31, and measures the impedance of the head section 120. As for the table memory 37, it is desirable that it is the memory in which elimination and writing are possible, for example, EEPROM and a flash memory.

[0024] In addition, the impedance measurement circuit 33 constitutes an impedance measurement means to measure the impedance in the frequency of the predetermined range of a head 31, and the cellular detector 38 constitutes a frequency-characteristics creation means to create the frequency characteristics of the measured impedance, and a distinction means to distinguish whether air bubbles have adhered to the above-mentioned piezoelectric device with the above-mentioned frequency characteristics.

[0025] Next, actuation of the ink jet printer by the gestalt of this operation is explained with reference to the flow chart of drawing 2 . Drawing 2 is the flow chart of the cellular detection approach by this invention.

[0026] In the ink jet printer constituted as mentioned above, before a print process is performed, CPU35 switches SUITCHI of the change-over circuit 34 to the impedance measurement circuit 33 side (step



S10).

[0027] Then, a test frequency is set as the predetermined range (step S12), and the impedance of the head section 120 in the frequency of the predetermined range is measured (step S14).

[0028] And sequential storing of the measurement data of the impedance which carried out in this way and was measured is carried out at memory 36 (step S16), and it judges whether measurement was completed or not (step S18).

[0029] When not judged with measurement termination at step S18, processing of step S12 to the step S18 is repeated until it is judged with return and measurement termination by test-frequency setup of step 12.

[0030] When judged with measurement termination in step S18, the frequency characteristics of the measured impedance are created (step S20).

[0031] Thus, the frequency characteristics of the created measurement impedance are compared with the impedance frequency characteristics which were beforehand searched for by experiment etc. and were stored in the table memory 37, and the existence of air bubbles is judged (step S24).

[0032] When air bubbles are judged at step S24 to be owner \*\*, head recovery is performed (step S28) and it returns to a test-frequency setup of step S12.

[0033] Moreover, in step S24, when judged with having no air bubbles, the change-over circuit 34 is switched to the head drive circuit 32 side (step S26), and processing is ended.

[0034] That is, if the existence of air bubbles is judged from the frequency characteristics of an impedance at step S24 and there are air bubbles, head recovery will be automatically performed at step S28, and air bubbles will be removed. By attracting ink from the nozzle 101 ( drawing 3 ) of the head section 120, head recovery removes air bubbles. At the time of cellular detection termination, SWITCH1 of the change-over circuit 34 is switched to the head drive circuit 32 side (step S26).

[0035] Subsequently, the principle of the cellular detection in step S24 mentioned above is explained. Introduction and the head section 120 are explained. Drawing 3 is the outline block diagram of the ink discharge part of the ink jet printer by this invention. In drawing 3 , 100 is an ink room where it fills up with ink 102, and this ink room 100 is formed by the nozzle member 103 by which the path formed the about several mm

nozzle 101 at the tip from dozens of micrometers, the reflective version 112, and the diaphragm 128.

[0036] The head section 120 is equipped with the diaphragm 128 formed of insulating materials, such as polyimide, and the piezoelectric device 129 which vibrates in hundreds of MHz from hundreds of kHz, and is formed by pasting up a diaphragm 128 and a piezoelectric device 129 with a binder 121.

[0037] It connects with a binder 121 and a piezoelectric device 129 through path cords 123 and 124, respectively, and the head control circuit 125 impresses a head driving signal to a piezoelectric device 129. Moreover, ink 102 is supplied into the ink room 100 from the ink supply way 114 established in the head section 120.

[0038] By impressing a head driving signal to a piezoelectric device 129 from the head control circuit 125, a piezoelectric device 129 vibrates and a diaphragm 128 is vibrated. By this, the ink 102 in the ink room 100 vibrates, and the energy with which the ink 102 in the ink room 100 exercises for the drawing upper part is further obtained in the inside of a reflecting plate 112, it adheres to discharge and a form 104 from a nozzle 101, and the print of the image is carried out. If air bubbles 106 are formed in the ink room 100 at this time as shown in drawing 3, the regurgitation of the ink from a nozzle 101 will not be normally made by telescopic motion of air bubbles 106, but print precision will fall.

[0039] Next, the impedance characteristic to the frequency of the head section 120 is explained. The calculated value of the impedance characteristic to the frequency of the head section 120 which drawing 4 requires for the gestalt 1 of implementation of this invention, and drawing 5 are the experimental values of the impedance characteristic to the frequency of the head section 120 concerning the gestalt 1 of implementation of this invention. In addition, the axis of ordinate of drawing 4 and drawing 5 expresses an impedance natural logarithm, and the axis of abscissa expresses the frequency. Moreover, a property in case a broken line has air bubbles, and a continuous line are properties in case there are no air bubbles.

[0040] As the broken line of drawing 4 shows, in the impedance characteristic 40 by the count result in case there are air bubbles, the point that an impedance becomes the minimum on a specific frequency is seen. In this case, it is the minimum near 8.7MHz and near 12MHz. In the impedance characteristic 41 by the count result in case there are no air bubbles, the impedance is not the minimum in these frequencies.

[0041] On the other hand, as shown in drawing 5, as for the impedance

characteristic 50 by the experimental result in case there are air bubbles, the point that an impedance becomes the minimum on a specific frequency is seen. In this case, it is the minimum near 8.7MHz and near 12MHz. In the impedance characteristic 41 by the experimental result in case there are no air bubbles, in these frequencies, the impedance is not the minimum.

[0042] In addition, in the experimental value of drawing 5 , unlike the calculated value of drawing 4 , the minimal value is looked at by 50a, 50b, 50c, 51a, and 51b, but this is based on the reflected wave generated with the reflecting plate 112.

[0043] Although it became clear that an impedance characteristic changed the minimum point of an impedance with the configuration of the piezoelectric device 129 of the head section 120, an ingredient, the ingredient of the diaphragm 128 inserted between a piezoelectric device 129 and ink, etc. as a result of the experiment, it was confirmed that the impedance characteristic to the frequency of the same head is mostly in agreement with calculated value and an experimental value. Moreover, although the absolute value of the minimal value (peak) in drawing 4 and drawing 5 changed when the path of air bubbles 106 changed, it became clear that the frequency is peculiar to a head. Therefore, existence of air bubbles is detectable by memorizing beforehand the frequency which becomes with this impedance characteristic of a proper, i.e., the minimum, in the table memory 37 at the head, measuring an impedance characteristic before a print and comparing the frequency data and the measurement value which were memorized by the table memory 37. And when the effect by the reflected wave also makes the table memory 37 memorize calculated value from a certain thing, it is desirable to carry out comparison examination of experimental data and the calculated value beforehand.

[0044] Moreover, it can respond simply [ modification of a piezoelectric device 129 etc. ], and flexibly by using table memory as a cellular existence distinction means to the impedance minimum point changing with the configuration of a piezoelectric device 129 etc.

[0045] By the way, although the above-mentioned explanation described the case where this invention was used for an ink jet-type printer, it cannot be overemphasized that it can use for the equipment which makes the liquid using other piezoelectric devices breathe out.

[0046]

[Effect of the Invention] Since this invention is constituted as explained above, it does so outstanding effectiveness which is indicated below.

[0047] By being able to detect, before carrying out the print of the air bubbles adhering to a head, and performing head recovery automatically, air bubbles can be lost completely, the normal ink regurgitation can be performed, and the quality and stabilized print can be obtained.

[0048] Moreover, a test pattern print can be lost and time amount and print cost can be reduced.

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**TECHNICAL FIELD**

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[Field of the Invention] This invention relates to the ink jet-type printer which carries out the print of the ink to the shape of jet especially at a print-ed medium with respect to the equipment which spouts a liquid, for example, the coater which applies the humidifier which carries out the regurgitation of the water, and ink.

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**PRIOR ART**

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[Description of the Prior Art] Drawing 6 shows the conventional ink jet printer indicated by JP,6-336026,A.

[0003] In drawing 6 , 1 expresses the head of an ink jet print and this head 1 consists of two or more nozzles 2, the pressure room 17 formed in housing 18, an ink way 15, piezo piezoelectric devices 16a and 16b to which the volume of the pressure room 17 is changed, and a heater 19 which heats housing 18.

[0004] Moreover, the ink cartridge 6 equipped with the ink container 4 is attached in housing 18, and the ink container 4 is open for free passage for two or more nozzles 2 through the ink way 15. Moreover, in the ink container 4, the porous bodies 9 and 13 for carrying out absorption maintenance of the ink are held, and the heater 5 for heating is attached in the external surface of the ink container 4.

[0005] Next, actuation of this conventional ink jet printer is explained. Usually, although ink is filled with the solid condition on the ink way 15, if an electrical potential difference is further impressed to the heater 19 of a head 1, the heater 5 of the ink container 4 and the ink absorbed by the ink and the porous bodies 9 and 13 in the ink way 15 will be melted. And the volume of the pressure room 17 is changed and a liquid ink drop is made to blow off from a nozzle 2 by impressing an electrical potential difference to the piezo piezoelectric devices 16a and 16b in this condition, and vibrating them. In connection with this, the ink absorbed by porous bodies 9 and 13 is supplied to the small [ every ] pressure room 17. A print object is obtained by making ink blow off from a head 1 by this actuation, and making it adhere to a form.

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**EFFECT OF THE INVENTION**

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[Effect of the Invention] Since this invention is constituted as explained above, it does so outstanding effectiveness which is indicated below.

[0047] By being able to detect, before carrying out the print of the air bubbles adhering to a head, and performing head recovery automatically, air bubbles can be lost completely, the normal ink regurgitation can be performed, and the quality and stabilized print can be obtained.

[0048] Moreover, a test pattern print can be lost and time amount and print cost can be reduced.

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## TECHNICAL PROBLEM

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[Problem(s) to be Solved by the Invention] In the conventional ink jet printer, when air bubbles went into the ink way 15, the normal ink regurgitation becomes impossible from two or more nozzles 2, the stripe went into the print object as a result, and there was a trouble that the quality and stabilized print object was no longer obtained.

[0007] Moreover, there is no means to check before carrying out the print of the existence of air bubbles, and the one-sheet print of the test pattern with which the regurgitation of ink judges whether it is normal needed to be carried out.

[0008] Moreover, when the print of the test pattern was carried out and a print object with air bubbles normal owing to was not obtained, ink supply recovery was performed as a recovery means, again, the print of the test pattern had to be carried out for the check, the repeat of checking whether ink has breathed out normally had to be performed, and there was a trouble that time amount and print cost started.

[0009] This invention aims at offering the ink jet printer which the impedance in the frequency of the arbitration of the piezoelectric device of a head is measured, and the frequency characteristics of an impedance are created, it distinguishes whether air bubbles have adhered to the ink interior of a room with those frequency characteristics; and ink supply recovery is automatically performed when air bubbles have adhered, and can perform cellular removal before being made in order to solve the trouble mentioned above, and carrying out a print.

[0010] Moreover, other purposes of this invention lose a test pattern print, and are to offer the ink jet printer which can reduce time amount and print cost.

[0011] Furthermore, the purpose of further others of this invention is to



offer the cellular detector and the cellular detection approach of detecting that air bubbles adhered to the head.

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## MEANS

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[Means for Solving the Problem] In order to attain the above-mentioned purpose, the ink jet printer concerning this invention is equipped with an impedance measurement means measure the impedance in the frequency of the predetermined range of the above-mentioned head, a frequency-characteristics creation means create the frequency characteristics of the measured impedance, and a distinction means distinguish whether air bubbles have adhered to the above-mentioned piezoelectric device with the above-mentioned frequency characteristics, in the ink jet printer which spouts ink to a print-ed medium by the drive of the piezoelectric device of a head.

[0013] Moreover, the ink jet printer of this invention is further equipped with the means for switching which switches the head driving means which drives the above-mentioned head, and the above-mentioned head driving means and the above-mentioned impedance measurement means.

[0014] Furthermore, the ink jet printer of this invention is further equipped with a means to remove the air bubbles adhering to the above-mentioned piezoelectric device, when adhesion of air bubbles is distinguished by the above-mentioned distinction means.

[0015] The ink jet printer of this invention is further equipped with the storage means in which elimination and writing are possible, and it is made to make the above-mentioned storage means memorize the impedance of the above-mentioned head further again at the time of initialization.

[0016] Moreover, the cellular detector concerning this invention is equipped with a means to measure the impedance in the frequency of the predetermined range of the above-mentioned head, a means to create the frequency characteristics of the measured impedance, and a

means to distinguish whether air bubbles have adhered to the above-mentioned piezoelectric device with the above-mentioned frequency characteristics, in the equipment which makes a liquid blow off by the drive of the piezoelectric device of a head.

[0017] Moreover, the cellular detection approach of this invention is equipped with the measurement process which measures the impedance of the frequency of the predetermined range of a head, and the distinction process which distinguishes the existence of the air bubbles adhering to the above-mentioned head from the frequency characteristics of the measured impedance.

[0018] Furthermore, the above-mentioned distinction process is equipped with the process which creates the frequency characteristics of the impedance measured in the above-mentioned measurement process, the process in comparison with the frequency characteristics of the impedance which was able to determine beforehand the frequency characteristics of the measurement impedance created by doing in this way, and the process which distinguishes the existence of the air bubbles adhering to the above-mentioned head based on the above-mentioned comparison result.

[0019]

[Embodiment of the Invention] Hereafter, the gestalt of implementation of this invention is explained with reference to an accompanying drawing.

[0020] Gestalt 1. drawing 1 of operation shows the outline configuration of the ink jet printer by the gestalt of 1 implementation of this invention.

[0021] The ink jet printer is equipped with the change-over circuit 34 which switches alternatively connection between the head 31 for a print, the head drive circuit 32 which drives a head 31, the cellular detector 38, and a head 31, the head drive circuit 32 and the cellular detector 38 in drawing 1 .

[0022] The cellular detector 38 is constituted by the impedance measurement circuit 33 which has connection with a head 31 switched by the switch circuit 34, CPU35, memory 36, and the table memory 37.

[0023] The impedance measurement circuit 33 detects the electrical potential difference and current in a setting frequency of the head section 120 ( drawing 3 ) of a head 31, and measures the impedance of the head section 120. As for the table memory 37, it is desirable that it is the memory in which elimination and writing are possible, for example, EEPROM and a flash memory.

[0024] In addition, the impedance measurement circuit 33 constitutes an impedance measurement means to measure the impedance in the frequency of the predetermined range of a head 31, and the cellular detector 38 constitutes a frequency-characteristics creation means to create the frequency characteristics of the measured impedance, and a distinction means to distinguish whether air bubbles have adhered to the above-mentioned piezoelectric device with the above-mentioned frequency characteristics.

[0025] Next, actuation of the ink jet printer by the gestalt of this operation is explained with reference to the flow chart of drawing 2. Drawing 2 is the flow chart of the cellular detection approach by this invention.

[0026] In the ink jet printer constituted as mentioned above, before a print process is performed, CPU35 switches SUITCHI of the change-over circuit 34 to the impedance measurement circuit 33 side (step S10).

[0027] Then, a test frequency is set as the predetermined range (step S12), and the impedance of the head section 120 in the frequency of the predetermined range is measured (step S14).

[0028] And sequential storing of the measurement data of the impedance which carried out in this way and was measured is carried out at memory 36 (step S16), and it judges whether measurement was completed or not (step S18).

[0029] When not judged with measurement termination at step S18, processing of step S12 to the step S18 is repeated until it is judged with return and measurement termination by test-frequency setup of step 12.

[0030] When judged with measurement termination in step S18, the frequency characteristics of the measured impedance are created (step S20).

[0031] Thus, the frequency characteristics of the created measurement impedance are compared with the impedance frequency characteristics which were beforehand searched for by experiment etc. and were stored in the table memory 37, and the existence of air bubbles is judged (step S24).

[0032] When air bubbles are judged at step S24 to be owner \*\*, head recovery is performed (step S28) and it returns to a test-frequency setup of step S12.

[0033] Moreover, in step S24, when judged with having no air bubbles, the change-over circuit 34 is switched to the head drive circuit 32 side

(step S26), and processing is ended.

[0034] That is, if the existence of air bubbles is judged from the frequency characteristics of an impedance at step S24 and there are air bubbles, head recovery will be automatically performed at step S28, and air bubbles will be removed. By attracting ink from the nozzle 101 ( drawing 3 ) of the head section 120, head recovery removes air bubbles. At the time of cellular detection termination, SWITCH of the change-over circuit 34 is switched to the head drive circuit 32 side (step S26).

[0035] Subsequently, the principle of the cellular detection in step S24 mentioned above is explained. Introduction and the head section 120 are explained. Drawing 3 is the outline block diagram of the ink discharge part of the ink jet printer by this invention. In drawing 3 , 100 is an ink room where it fills up with ink 102, and this ink room 100 is formed by the nozzle member 103 by which the path formed the about several mm nozzle 101 at the tip from dozens of micrometers, the reflective version 112, and the diaphragm 128.

[0036] The head section 120 is equipped with the diaphragm 128 formed of insulating materials, such as polyimide, and the piezoelectric device 129 which vibrates in hundreds of MHz from hundreds of kHz, and is formed by pasting up a diaphragm 128 and a piezoelectric device 129 with a binder 121.

[0037] It connects with a binder 121 and a piezoelectric device 129 through path cords 123 and 124, respectively, and the head control circuit 125 impresses a head driving signal to a piezoelectric device 129. Moreover, ink 102 is supplied into the ink room 100 from the ink supply way 114 established in the head section 120.

[0038] By impressing a head driving signal to a piezoelectric device 129 from the head control circuit 125, a piezoelectric device 129 vibrates and a diaphragm 128 is vibrated. By this, the ink 102 in the ink room 100 vibrates, and the energy with which the ink 102 in the ink room 100 exercises for the drawing upper part is further obtained in the inside of a reflecting plate 112, it adheres to discharge and a form 104 from a nozzle 101, and the print of the image is carried out. If air bubbles 106 are formed in the ink room 100 at this time as shown in drawing 3 , the regurgitation of the ink from a nozzle 101 will not be normally made by telescopic motion of air bubbles 106, but print precision will fall.

[0039] Next, the impedance characteristic to the frequency of the head section 120 is explained. The calculated value of the impedance characteristic to the frequency of the head section 120 which drawing 4

requires for the gestalt 1 of implementation of this invention, and drawing 5 are the experimental values of the impedance characteristic to the frequency of the head section 120 concerning the gestalt 1 of implementation of this invention. In addition, the axis of ordinate of drawing 4 and drawing 5 expresses an impedance natural logarithm, and the axis of abscissa expresses the frequency. Moreover, a property in case a broken line has air bubbles, and a continuous line are properties in case there are no air bubbles.

[0040] As the broken line of drawing 4 shows, in the impedance characteristic 40 by the count result in case there are air bubbles, the point that an impedance becomes the minimum on a specific frequency is seen. In this case, it is the minimum near 8.7MHz and near 12MHz. In the impedance characteristic 41 by the count result in case there are no air bubbles, the impedance is not the minimum in these frequencies.

[0041] On the other hand, as shown in drawing 5, as for the impedance characteristic 50 by the experimental result in case there are air bubbles, the point that an impedance becomes the minimum on a specific frequency is seen. In this case, it is the minimum near 8.7MHz and near 12MHz. In the impedance characteristic 41 by the experimental result in case there are no air bubbles, in these frequencies, the impedance is not the minimum.

[0042] In addition, in the experimental value of drawing 5, unlike the calculated value of drawing 4, the minimal value is looked at by 50a, 50b, 50c, 51a, and 51b, but this is based on the reflected wave generated with the reflecting plate 112.

[0043] Although it became clear that an impedance characteristic changed the minimum point of an impedance with the configuration of the piezoelectric device 129 of the head section 120, an ingredient, the ingredient of the diaphragm 128 inserted between a piezoelectric device 129 and ink, etc. as a result of the experiment, it was confirmed that the impedance characteristic to the frequency of the same head is mostly in agreement with calculated value and an experimental value. Moreover, although the absolute value of the minimal value (peak) in drawing 4 and drawing 5 changed when the path of air bubbles 106 changed, it became clear that the frequency is peculiar to a head. Therefore, existence of air bubbles is detectable by memorizing beforehand the frequency which becomes with this impedance characteristic of a proper, i.e., the minimum, in the table memory 37 at the head, measuring an impedance characteristic before a print and comparing the frequency data and the measurement value which were memorized by the table memory 37. And

when the effect by the reflected wave also makes the table memory 37 memorize calculated value from a certain thing, it is desirable to carry out comparison examination of experimental data and the calculated value beforehand.

[0044] Moreover, it can respond simply [ modification of a piezoelectric device 129 etc. ], and flexibly by using table memory as a cellular existence distinction means to the impedance minimum point changing with the configuration of a piezoelectric device 129 etc.

[0045] By the way, although the above-mentioned explanation described the case where this invention was used for an ink jet-type printer, it cannot be overemphasized that it can use for the equipment which makes the liquid using other piezoelectric devices breathe out.

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[Translation done.]

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is a block diagram showing the outline configuration of the ink jet printer by the gestalt of the 1 operation by this invention.

[Drawing 2] It is drawing showing the flow chart of the cellular detector of the ink jet printer of drawing 1 .

[Drawing 3] It is the schematic diagram showing the head of the ink jet printer by this invention.

[Drawing 4] It is drawing (calculated value) showing an example of the impedance characteristic of a head.

[Drawing 5] It is drawing (experimental value) showing an example of the impedance characteristic of a head.

[Drawing 6] It is drawing showing the conventional ink jet head.

[Description of Notations]

31 A head, 32 A head drive circuit, 33 An impedance measurement circuit, 34 change-over circuits, 35 CPU, 36 Memory, 37 Table memory, 40 An impedance characteristic in case there are air bubbles, 41 Impedance characteristic in case there are no air bubbles.

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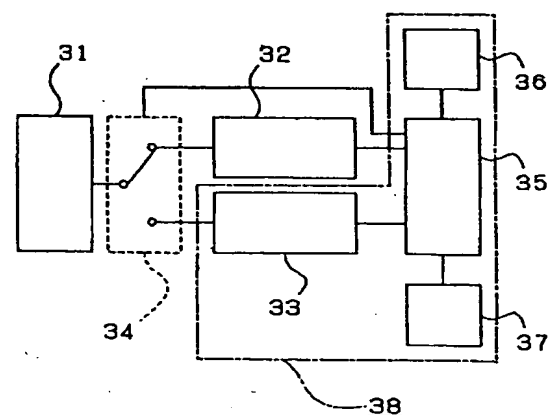
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(54) 【発明の名称】 インクジェット式プリンタ、気泡検出回路及び気泡検出方法

(57) 【要約】

【課題】 ヘッドのインク室内部に気泡があるとインク吐出が正常に行われなくなる。このインクの気泡を検出し最適なヘッド回復処理を行うことにより正常なインク吐出を行い、高品質で安定した印画を得る。

【解決手段】 この発明に係る気泡検出回路及び方法においては、ヘッドの圧電素子の任意の周波数におけるインピーダンスを測定し、インピーダンスの周波数特性を作成し、その周波数特性により圧電素子に気泡が付着しているかを判別するものである。



31:ヘッド  
32:ヘッド駆動回路  
33:インピーダンス測定回路  
34:切換え回路  
35:CPU  
36:メモリ  
37:テーブルメモリ  
38:気泡検出回路

## 【特許請求の範囲】

【請求項1】 ヘッドの圧電素子の駆動によりインクを被印画媒体に噴出するインクジェット式プリンタにおいて、

上記ヘッドの所定範囲の周波数におけるインピーダンスを測定するインピーダンス測定手段と、  
測定されたインピーダンスの周波数特性を作成する周波数特性作成手段と、

上記周波数特性により上記圧電素子に気泡が付着しているかを判別する判別手段と、

を備えることを特徴とするインクジェット式プリンタ。

【請求項2】 上記ヘッドを駆動するヘッド駆動手段と、

上記ヘッド駆動手段と上記インピーダンス測定手段とを切り換える切換手段と、

を更に備えることを特徴とする請求項1記載のインクジェット式プリンタ。

【請求項3】 上記判別手段により気泡の付着が判別されたとき、上記圧電素子に付着した気泡を除去する手段を更に備えることを特徴とする請求項1記載のインクジェット式プリンタ。

【請求項4】 消去及び書き込み可能な記憶手段を更に備え、初期設定時に、上記ヘッドのインピーダンスを上記記憶手段に記憶させるようにしたことを特徴とする請求項1乃至3のいずれかに記載のインクジェット式プリンタ。

【請求項5】 ヘッドの圧電素子の駆動により液体を噴出させる装置において、

上記ヘッドの所定範囲の周波数におけるインピーダンスを測定する手段と、

測定されたインピーダンスの周波数特性を作成する手段と、

上記周波数特性により上記圧電素子に気泡が付着しているかを判別する手段と、

を備えることを特徴とする気泡検出回路。

【請求項6】 ヘッドの所定範囲の周波数のインピーダンスを測定する測定過程と、

測定されたインピーダンスの周波数特性より上記ヘッドに付着した気泡の有無を判別する判別過程と、

を備えることを特徴とする気泡検出方法。

【請求項7】 上記判別過程は、上記測定過程で測定されたインピーダンスの周波数特性を作成する過程と、  
このようにして作成された測定インピーダンスの周波数特性を、予め決められたインピーダンスの周波数特性と比較する過程と、

上記比較結果に基づいて、上記ヘッドに付着した気泡の有無を判別する過程と、

を備えることを特徴とする請求項6記載の気泡検出方法。

【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】 この発明は、液体を噴出する装置、例えば水を吐出する加湿器やインクを塗布する塗布装置等に係わり、特に、インクをジェット状に被印画媒体に印画するインクジェット式のプリンタに関する。

## 【0002】

【従来の技術】 図6は、例えば特開平6-336026号公報に記載された従来のインクジェットプリンタを示している。

10 【0003】 図6において、1はインクジェットプリントのヘッドを表しており、このヘッド1は、複数のノズル2と、ハウジング18に形成された圧力室17と、インク路15と、圧力室17の容積を変化させるピエゾ圧電素子16a、16bと、ハウジング18を加熱するヒータ19とで構成されている。

【0004】 また、ハウジング18には、インク容器4を備えたインクカートリッジ6が取り付けられており、インク容器4はインク路15を介して複数のノズル2に連通している。また、インク容器4内には、インクを吸収保持するための多孔質体9、13が収容されており、インク容器4の外面には、加熱用のヒータ5が取り付けられている。

【0005】 次に、この従来のインクジェットプリンタの動作について説明する。通常、インク路15には、インクが固体の状態で満たされているが、インク容器4のヒータ5、さらにはヘッド1のヒータ19に電圧を印加すると、インク路15内のインク及び多孔質体9、13に吸収されているインクが溶かされる。そして、この状態でピエゾ圧電素子16a、16bに電圧を印加してそれらを振動させることにより圧力室17の容積を変化させて、ノズル2よりインク液滴を噴出させる。これに伴い、多孔質体9、13に吸収されているインクは僅かずつ圧力室17に供給される。この動作によりインクをヘッド1から噴出させて用紙に付着させることにより印画物を得る。

## 【0006】

【発明が解決しようとする課題】 従来のインクジェットプリンタでは、インク路15に気泡が入った場合には、複数のノズル2から正常なインク吐出ができなくなり、結果として印画物にスジが入り、高品質で安定した印画物が得られなくなるという問題点があった。

【0007】 また、気泡の有無を印画する前に確認する手段がなく、インクの吐出が正常かどうか判断するテストパターンを一枚印画する必要があった。

【0008】 また、テストパターンを印画した際に、気泡が原因で正常な印画物が得られなかった場合、回復手段としてインク供給回復処理を行い、再度、確認のためにテストパターンを印画し、正常にインクが吐出したかどうかを確認することの繰り返しを行わなければならず、時間と印画コストがかかるという問題点があった。

【0009】この発明は、上述した問題点を解決するためになされたものであり、印画をする前に、ヘッドの圧電素子の任意の周波数におけるインピーダンスを測定してインピーダンスの周波数特性を作成し、その周波数特性によりインク室内に気泡が付着しているかを判別し、気泡が付着している場合には自動的にインク供給回復処理を行い、気泡除去を行うことが可能なインクジェット式プリンタを提供することを目的とする。

【0010】また、本発明の他の目的は、テストパターン印画を無くし、時間と印画コストを削減し得るインク

ジェット式プリンタを提供することにある。

【0011】さらに、本発明の更に他の目的は、ヘッドに気泡が付着したことを検出し得る気泡検出回路及び気泡検出方法を提供することにある。

【0012】

【課題を解決するための手段】上記目的を達成するため、この発明に係るインクジェット式プリンタは、ヘッドの圧電素子の駆動によりインクを被印画媒体に噴出するインクジェット式プリンタにおいて、上記ヘッドの所定範囲の周波数におけるインピーダンスを測定するイン

ピーダンス測定手段と、測定されたインピーダンスの周波数特性を作成する周波数特性作成手段と、上記周波数特性により上記圧電素子に気泡が付着しているかを判別する判別手段とを備えるものである。

【0013】また、本発明のインクジェット式プリンタは、上記ヘッドを駆動するヘッド駆動手段と、上記ヘッド駆動手段と上記インピーダンス測定手段とを切り換える切換手段と、を更に備えるものである。

【0014】さらに、本発明のインクジェット式プリンタは、上記判別手段により気泡の付着が判別されたとき、上記圧電素子に付着した気泡を除去する手段を更に備えるものである。

【0015】さらにまた、本発明のインクジェット式プリンタは、消去及び書き込み可能な記憶手段を更に備え、初期設定時に、上記ヘッドのインピーダンスを上記記憶手段に記憶させるようにしたものである。

【0016】また、本発明に係る気泡検出回路は、ヘッドの圧電素子の駆動により液体を噴出させる装置において、上記ヘッドの所定範囲の周波数におけるインピーダンスを測定する手段と、測定されたインピーダンスの周波数特性を作成する手段と、上記周波数特性により上記圧電素子に気泡が付着しているかを判別する手段とを備えるものである。

【0017】また、本発明の気泡検出方法は、ヘッドの所定範囲の周波数のインピーダンスを測定する測定過程と、測定されたインピーダンスの周波数特性より上記ヘッドに付着した気泡の有無を判別する判別過程とを備えるものである。

【0018】さらに、上記判別過程は、上記測定過程で測定されたインピーダンスの周波数特性を作成する過程

と、このようにして作成された測定インピーダンスの周波数特性を、予め決められたインピーダンスの周波数特性と比較する過程と、上記比較結果に基づいて、上記ヘッドに付着した気泡の有無を判別する過程とを備えるものである。

【0019】

【発明の実施の形態】以下、添付図面を参照してこの発明の実施の形態について説明する。

【0020】実施の形態1. 図1はこの発明の一実施の形態によるインクジェット式プリンタの概略構成を示している。

【0021】図1において、インクジェット式プリンタは、プリント用のヘッド31と、ヘッド31を駆動するヘッド駆動回路32と、気泡検出回路38と、ヘッド31とヘッド駆動回路32及び気泡検出回路38との間の接続を択一的に切り換える切換回路34とを備えている。

【0022】気泡検出回路38は、切り換え回路34によりヘッド31との接続を切り換えられるインピーダンス測定回路33と、CPU35と、メモリ36と、テーブルメモリ37とにより構成されている。

【0023】インピーダンス測定回路33は、ヘッド31のヘッド部120（図3）の設定周波数における電圧及び電流を検出し、ヘッド部120のインピーダンスを測定する。テーブルメモリ37は、消去及び書き込み可能なメモリ、例えばEEPROMやフラッシュメモリであることが好ましい。

【0024】なお、インピーダンス測定回路33は、ヘッド31の所定範囲の周波数におけるインピーダンスを測定するインピーダンス測定手段を構成し、気泡検出回路38は、測定されたインピーダンスの周波数特性を作成する周波数特性作成手段と、上記周波数特性により上記圧電素子に気泡が付着しているかを判別する判別手段とを構成する。

【0025】次に、この実施の形態によるインクジェット式プリンタの動作について、図2のフローチャートを参照して説明する。図2は本発明による気泡検出方法のフローチャートである。

【0026】上述のように構成されたインクジェット式プリンタにおいて、印画プロセスが実行される前に、CPU35が、切換回路34のスイッチをインピーダンス測定回路33側に切り換える（ステップS10）。

【0027】その後、測定周波数を所定範囲に設定し（ステップS12）、所定範囲の周波数におけるヘッド部120のインピーダンスを測定する（ステップS14）。

【0028】そして、このようにして測定したインピーダンスの測定データをメモリ36に順次格納し（ステップS16）、測定が終了したか否かを判定する（ステップS18）。

【0029】ステップS18で測定終了と判定されない場合には、ステップ12の測定周波数設定に戻り、測定終了と判定されるまで、ステップS12からステップS18の処理を繰り返す。

【0030】ステップS18において測定終了と判定された場合には、測定されたインピーダンスの周波数特性を作成する（ステップS20）。

【0031】このようにして作成された測定インピーダンスの周波数特性と、予め実験等により求められテーブルメモリ37に格納されたインピーダンス周波数特性とを比較して、気泡の有無を判定する（ステップS24）。

【0032】ステップS24で気泡が有りと判定された場合には、ヘッド回復処理を行い（ステップS28）、ステップS12の測定周波数設定に戻る。

【0033】また、ステップS24において、気泡無しと判定された場合には、切換回路34をヘッド駆動回路32側に切り換えて（ステップS26）、処理を終了する。

【0034】すなわち、ステップS24で気泡の有無をインピーダンスの周波数特性より判断し、気泡があれば、ステップS28で自動的にヘッド回復処理を行って気泡を除去する。ヘッド回復処理はヘッド部120のノズル101（図3）からインクを吸引することにより、気泡を除去する。気泡検出終了時には、切換回路34のスイッチをヘッド駆動回路32側に切り換えておく（ステップS26）。

【0035】次いで、上述したステップS24における気泡検出の原理について説明する。初めに、ヘッド部120について説明する。図3はこの発明によるインクジェット式プリンタのインク吐出部の概略構成図である。図3において、100はインク102が充填されるインク室であり、このインク室100は、径が数十 $\mu$ mから数mm程度のノズル101を先端に形成したノズル部材103と、反射版112と、振動板128とにより形成される。

【0036】ヘッド部120は、例えばポリイミド等の絶縁材料により形成された振動板128と、例えば数百kHzから数百MHzの範囲で振動する圧電素子129とを備え、振動板128と圧電素子129とを接着材121により接着させることにより形成される。

【0037】ヘッド制御回路125は、接続線123、124を介して接着材121と圧電素子129とにそれぞれ接続され、圧電素子129にヘッド駆動信号を印加する。また、インク102はヘッド部120に設けたインク供給路114からインク室100内へ供給される。

【0038】ヘッド制御回路125より圧電素子129にヘッド駆動信号を印加することにより、圧電素子129が振動して振動板128を振動させる。これにより、インク室100内のインク102が振動し、さらに反射

板112の内面にてインク室100内のインク102が図面上方に運動するエネルギーを得て、ノズル101から吐出し、用紙104に付着して画像が印画される。このとき、図3に示すように、気泡106がインク室100内に形成されていると、気泡106の伸縮によりノズル101からのインクの吐出が正常になされず、印画精度が低下する。

【0039】次に、ヘッド部120の周波数に対するインピーダンス特性について説明する。図4はこの発明の実施の形態1に係るヘッド部120の周波数に対するインピーダンス特性の計算値、図5はこの発明の実施の形態1に係るヘッド部120の周波数に対するインピーダンス特性の実験値である。なお、図4及び図5の縦軸はインピーダンス自然対数を表し、横軸は周波数を表している。また、破線は気泡が有るときの特性、実線は気泡が無いときの特性である。

【0040】図4の破線で示すように、気泡が有る場合の計算結果によるインピーダンス特性40では、特定の周波数でインピーダンスが極小になる点が見られる。この場合は、8.7MHz付近と、12MHz付近で極小となっている。気泡の無い場合の計算結果によるインピーダンス特性41では、これらの周波数においてインピーダンスは極小になっていない。

【0041】一方、図5に示すように、気泡が有る場合の実験結果によるインピーダンス特性50は、特定周波数でインピーダンスが極小になる点が見られる。この場合は8.7MHz付近と、12MHz付近で極小となっている。気泡の無い場合の実験結果によるインピーダンス特性41は、これらの周波数においてインピーダンスは極小になっていない。

【0042】なお、図5の実験値においては、図4の計算値と異なり、50a、50b、50c、51a、51bにも極小値が見られるが、これは、反射板112により発生した反射波によるものである。

【0043】実験の結果、インピーダンス特性はヘッド部120の圧電素子129の形状や材料、圧電素子129とインクとの間に挟む振動板128の材料などによりインピーダンスの極小点が変わることが判明したが、同一のヘッドの周波数に対するインピーダンス特性は、計算値及び実験値でほぼ一致することが確かめられた。また、気泡106の径が変化すると、図4及び図5における極小値（ピーク）の絶対値は変化するが、その周波数はヘッドに固有であることが判明した。従って、ヘッドに固有のこのインピーダンス特性を、即ち極小となる周波数を予めテーブルメモリ37に記憶しておき、印画前に、インピーダンス特性を計測し、テーブルメモリ37に記憶された周波数データと計測値を比較することにより、気泡の存在を検知することができる。そして、反射波による影響もあることから、計算値をテーブルメモリ37に記憶させるときは、予め実験データと計算値とを

比較検討しておくことが好ましい。

【0044】また、圧電素子129の形状などによりインピーダンス極小点が変わることに対して、気泡有無判別手段としてテーブルメモリを用いることにより、圧電素子129の変更などに簡単且つ柔軟に対応することができる。

【0045】ところで上記説明では、この発明をインクジェット式のプリンタに利用する場合について述べたが、その他の圧電素子を用いた液体を吐出させる装置に利用できることはいうまでもない。

【0046】

【発明の効果】この発明は、以上説明したように構成されているので、以下に記載されるような優れた効果を奏する。

【0047】ヘッドに付着した気泡を印画する前に検出することができ、また、自動的にヘッド回復処理を行うことにより気泡を完全に無くし、正常なインク吐出を行うことができ、高品質で安定した印画を得ることができる。

【0048】また、テストパターン印画を無くし、時間

と印画コストを削減することができる。

【図面の簡単な説明】

【図1】 この発明による一実施の形態によるインクジェット式プリンタの概略構成を表すブロック図である。

【図2】 図1のインクジェット式プリンタの気泡検出回路のフローチャートを示す図である。

【図3】 本発明によるインクジェット式プリンタのヘッドを示す概略図である。

【図4】 ヘッドのインピーダンス特性の一例を示す図（計算値）である。

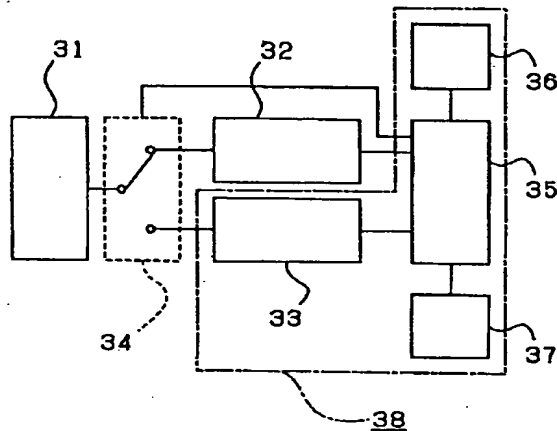
【図5】 ヘッドのインピーダンス特性の一例を示す図（実験値）である。

【図6】 従来のインクジェットヘッドを示す図である。

【符号の説明】

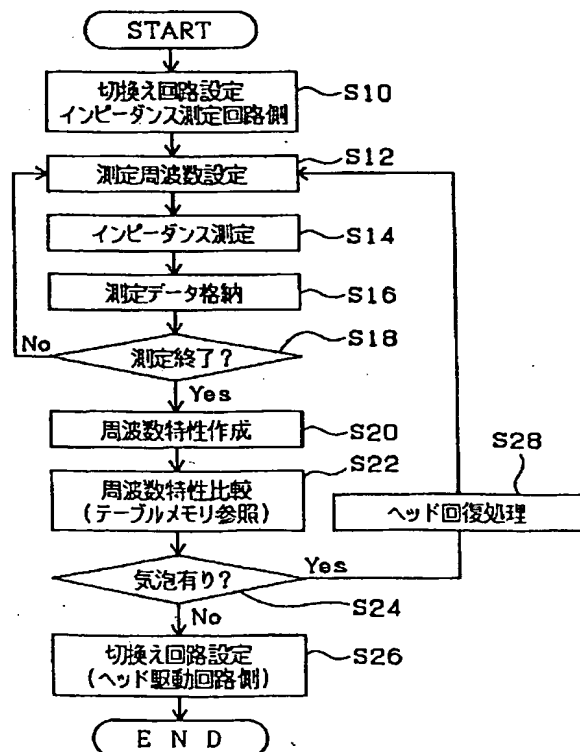
31 ヘッド、32 ヘッド駆動回路、33 インピーダンス測定回路、34 切換回路、35 CPU、36 メモリ、37 テーブルメモリ、40 気泡が有る場合のインピーダンス特性、41 気泡が無い場合のインピーダンス特性。

【図1】

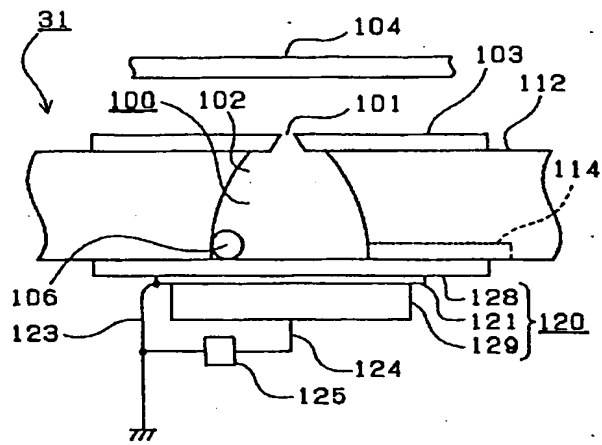


31:ヘッド  
32:ヘッド駆動回路  
33:インピーダンス測定回路  
34:切換回路  
35:CPU  
36:メモリ  
37:テーブルメモリ  
38:気泡検出回路

【図2】

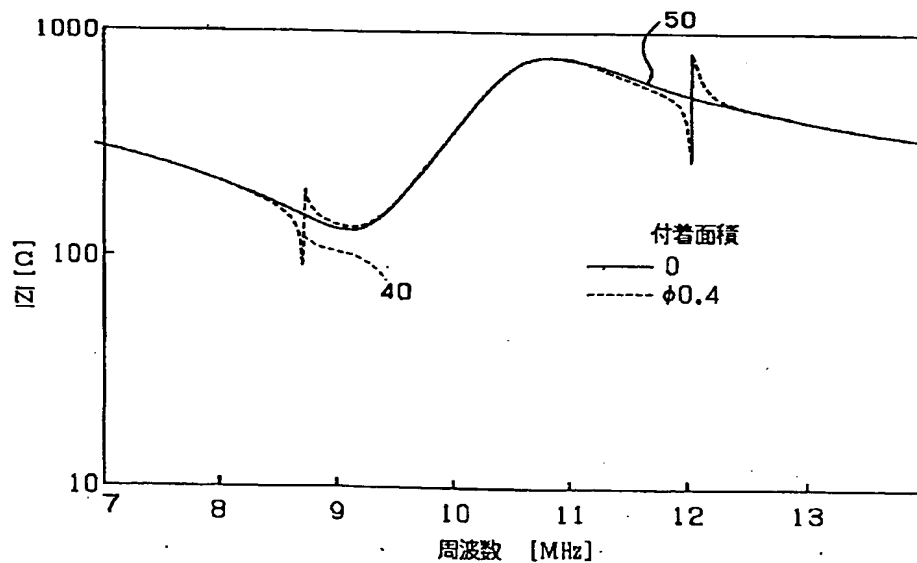


【図3】

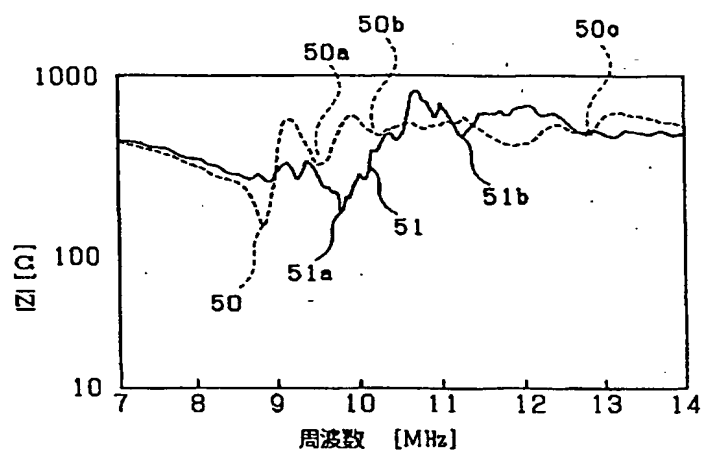


100: インク室  
 101: ノズル  
 102: インク  
 103: ノズル部材  
 104: 紙  
 106: 気泡  
 112: 反射板  
 114: インク供給路  
 120: ヘッド部

【図4】



【図5】

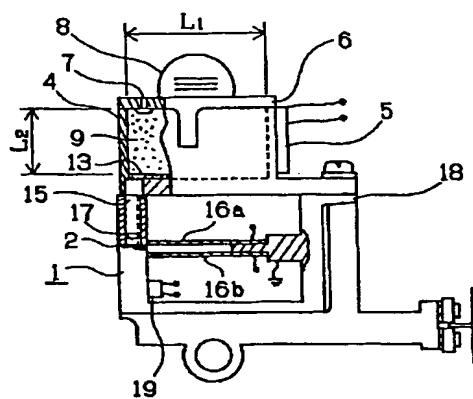


ヘッドのインピーダンス特性(測定結果,T13)

50: 気泡がある場合のインピーダンス特性

51: 気泡がない場合のインピーダンス特性

【図6】



1: インクジェットプリンタのヘッド

2: 複数のノズル

4: インク容器

5,19: ヒータ

6: インクカートリッジ

8: 把手

9,13: 多孔質体

15: インク路

16a,16b: ピエゾ圧電素子

17: 圧力室

18: ハウジング

フロントページの続き

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